BROOKHAVEN NATIONAL LABORATORY
NATIONAL SYNCHROTRON LIGHT SOURCE

MEMORANDUM

DATE: 1 August 2000

TO: Sam Krinsky, Michael Hart, Richard Osgood, Peter Paul

CC: NSLS Management Group, FEL Project Team

FROM: William S. Graves, Richard Heese, Erik D. Johnson

SUBJECT: **DUV-FEL Project Report; Period ended 28 July 2000**

Work in Progress:
Our July shutdown activities were quite productive and came off more or less according to plan. In addition to the planned tasks described in our last project report, several items came up as work progressed that were addressed. What we accomplished;

COUR (COherent Undulator Radiation) The vacuum system was installed as was the support for the undulator itself. This installation required a modification of the lead shielding which has been completed and reviewed. A modified shielding checklist was prepared, reviewed and approved that reflects these changes and has been posted on our web site as a revised procedure.

Linac We installed a new pop-in monitor (POP 10) just upstream of the COUR chamber. An RF pick-up was also added to the load for accelerating tank 1.

Klystron Servicing and Maintenance The arcing and general bad intermittent behavior observed in system A was tracked down to a loose socket on the tube itself. Breakdowns in the oil at this location is suspected to have contributed to the discoloration in the insulating oil. The tank was emptied, and a new holder for the connector was prepared and installed that keeps the connector from sliding off of the terminals for the tube. Fresh mineral oil was used for refilling the tank. Systems B and C were given similar maintenance. Some service work on the cables and connectors inside the System C modulator was also performed. In the running since we returned to commissioning, the intermittent problems with the klystrons have not occurred.

Photo-injector This area has been a major focus of the shutdown work, and the commissioning activities since everything was reassembled. One major result was the finding that our emittance compensation solenoid was 'Amp-Turn Challenged' by a factor of two. This is a gentle PC way of saying we incorrectly wired the magnet when it was installed so only half of the pancake windings were powered. Once discovered and corrected, a simple hand-held hall probe matched the current-field measurements made when the solenoid was in the laboratory. The gun itself has also received considerable attention since our last report.

After a review of the available commissioning measurements, we agreed to undertake a replacement of the cathode. The drivers behind this decision were known damage to the cathode surface in the form of pits, and a desire to reduce the gun operating temperature to minimize thermal gradients across the gun. Recall that up to the point where this decision was made, we had achieved an electron energy of 3 MeV (lower

than the 5 or so MeV we expected) and that the beam divergence seemed too large, even when the effects of the low solenoid field were considered.

XiJie Wang coordinated the preparation of a new copper cathode plate and installed it himself. Examination of the removed cathode plate showed two interesting things. The only arcing visible in the system was near the sealing surface on the cathode; no arc marks inside the half-cell of the gun. In addition we later noted that the arcs seemed to occur only in areas where some of the braze alloy had crept onto the stainless steel surface where the helicoflex gasket seats on the cathode. The other interesting feature was the size of the pits at the cathode center. There were four major features, generally under 100 micrometers across and 10 to 12 micrometers deep, which does not seem so large when one considers the nominal size of the laser beam is 1.5 mm and larger. It was interesting to note that during the microscope measurements illumination light run through the objective scattered like mad while the remainder of the cathode surface finish was quite fine and highly reflective. Measurements of the cathode dimensions were taken to aid in remachining it for future use.

This last set of measurements may be quite important. When the new cathode plate was installed the gasket was compressed until the plate and gun reference surfaces banked on each other before the correct mode separation was achieved at nominal operating temperature. XiJie used the measurements obtained on the old cathode (both physical and beam performance) to provide us with guidelines for remachining the old cathode plate so it could be used to replace the newly installed plate if necessary. Bill Graves ran an extensive series of photo-injector studies with the new cathode running at a low temperature (12.5 C) to get the gun on resonance. He prepared a status report of the measurements thus far. The basic conclusions of these careful measurements are that the RF power to the gun should be adequate to produce a high field in the gun. However measurements of the beam charge and energy indicate that the field is low relative to the power delivered. Evaluation of the measurements outlined above, additional measurements now underway, and comparison with simulations will help us determine how best to proceed with the gun to get the photoinjector performance up to scratch.

In related activities, the old cathode was carefully remachined to the new specification, polished and prepared for bakeout. During our shutdown work, the normal incidence mirrors were evaluated and found to be sound (no observable damage from beam studies thus far). A dummy cathode plate was prepared with a window at the plane of the cathode surface that can be used to evaluate focusing conditions at the cathode. This has not yet been used, but is at the ready should the need arise.

Other Activities The last Operational Readiness Review item has been completed and a request has been filed to close out the ORR. Development and design of the lattice for transporting the beam to NISUS has progressed to the point where detailed mechanical design can start. Preparing for the installation of the FEL transport optics will be a major activity over the next weeks and months. Our beam studies activities have brought a number of new tools on line quite rapidly that allow shot by shot analysis of the beam characteristics.

Work Planned for Next Week(s):

We will continue with beam studies to understand the properties of the photo-injector well enough to make a decision regarding next steps to bring its performance up to design values. This should be accomplished before we complete the fault studies for the Accelerator Readiness Review. A number of small punch-list items have been identified that will be accomplished over the next couple of weeks. They are primarily speed and convenience of operation issues having to do with improved programming and

linking the beam analysis tools to the control system so routine measurements can be made more or less automatically.

The work on NISUS continues, with the completion of the assembly of all of the pop-in monitors and preparation of the vacuum system for bake-out. This part of the project will continue over the next several months to be ready for the start of FEL experimentation later this year.

Management:

We have had some personnel changes in the last month. Jim Ansilmini who has been primarily responsible for the high quality mechanical work on NISUS has taken a more senior position in the chemistry department. We wish him well with his new responsibilities; his position with the project leaves us with a significant opening. Phil Marino, who is well known around the project, left the consulting firm he worked for to become a member of the NSLS staff. He will continue working on the DUV-FEL. Christine Murffit has joined the project for the summer and has been involved in the development of labview interfaces to our equipment and implementing the save/restore and history programs for our control system. Jim Rose has joined the staff of the NSLS and is bringing his extensive RF engineering expertise to the measurement and analysis of our photoinjector and linac systems. Beyond the people now full time assigned to the activities at the DUV-FEL, a larger cross-section of the department staff is participating in the project. This help is certainly welcomed as we continue to work through bringing the machine on line.